

DIGITAL RADIO TELEPHONE  
FOR A DIGITAL MOBILE RADIO COMMUNICATION SYSTEM

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**BACKGROUND OF THE INVENTION**

5      **Field of the Invention**

The invention relates to a digital radio telephone used in a digital mobile radio communication system such as a land mobile / portable phone system and a PHS (Personal Handyphone System) adopting a digital telephone system for example. The invention particularly relates to a digital radio telephone having a function of storing a mate telephone number (hereinafter, referred to as "incoming telephone number") and a function of calling the stored phone number (hereinafter, referred to as "incoming redialing function").

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**Description of the prior art**

FIG. 11 shows a system configuration of an analog radio telephone having a conventional incoming redialing function disclosed in a laid-open Japanese patent publication No. 5-14274. This type of conventional telephone receives mate telephone number information of an incoming call together with an analog audio signal via a radio channel using a communication channel in a form of a DTMF (Dual Tone Multi Frequency) signal where a plurality of frequency signals are superposed, and then, stores the telephone number information in a memory.

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An operation of the incoming redialing function of the analog radio telephone is explained below. First, a radio signal ~~including~~ containing a control information received via an antenna 6 using a control channel is demodulated by a radio portion 5 and outputted as a control signal which is an analog signal in a base band. Control information in the demodulated control signal is decoded by a decoder 15 and is processed by a microcomputer 10 to establish the radio channel. Then, a radio signal ~~including~~ containing the telephone number information received via the antenna 6 using the communication

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channel is demodulated by the radio portion 5 and outputted as the DTMF signal which is the analog signal in the base band. The telephone number information in the demodulated DTMF signal is detected, judged, and <sup>decoded</sup> by a DTMF receiver 16. Then, the output <sup>receiver 16</sup> signal from the DTMF signal is processed by the microcomputer 10 and stored in a memory 12. On the other hand, in case of calling by redialing, the telephone number information stored in advance in the memory 12 by the microcomputer 10 is read out, encoded by an encoder 17, modulated by the radio portion 5, then, transmitted from the antenna 6 as a radio signal.

Since the incoming redialing function in the conventional analog radio telephone constructed as explained above requires the DTMF receiver for detecting the telephone number information in addition to the construction for operating the telephone function itself, there is a problem that the conventional analog radio telephone construction is complicated. Also, since the conventional analog radio telephone redials using the telephone number information stored only in the memory, it is difficult to provide an incoming redialing function having high-performance or multifunction in consideration of user service.

It is an object of the present invention to provide a digital radio telephone having a high-performance incoming redialing function by maximally using the digital processing ability naturally included in a digital radio telephone.

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#### SUMMARY OF THE INVENTION

According to one aspect of the invention, a digital radio telephone comprises a radio portion for receiving a radio signal modulated by an encoded digital signal including control information, for demodulating and outputting the encoded digital signal; a control signal processing portion for decoding the demodulated encoded digital signal to obtain the control information; a telephone number information

detecting means for detecting whether the decoded control information includes mate telephone number information; a memory for storing the telephone number information; a time information management means for specifying an incoming time of the telephone number information to output a time information; and a memory management means for recording the telephone number information corresponding to the time information into the memory.

According to another aspect of the invention, a digital radio telephone used for an external line and an extension line further comprises an extension / external line judging means for judging whether the telephone number information is from the extension or from the external line; an external line information addition means for adding an external line calling information to the telephone number information according to a judging result to output as new telephone number information.

Preferably, the memory management means in the digital radio telephone records a predetermined number of telephone number information in the memory starting with telephone number information received most recently.

According to further aspect of the invention, a digital radio telephone further comprises an operating portion for supplying an operating signal, and a display portion for displaying various information during operation, wherein, the memory comprises a first memory portion for storing the telephone number information included in the control information and a second memory portion for registering other telephone numbers information inputted from the operating portion corresponding identification information to the telephone numbers; and the operating portion instructs the display portion to display the telephone number information recorded in the first memory portion together with the corresponding identification information recorded in the second memory portion.

According to further aspect of the invention, a digital radio telephone further comprises an operating portion for supplying an operating signal, a display portion for

displaying various information during operation, wherein, the memory comprises a first memory portion for storing the telephone number information included in the control information and a second memory portion for registering other telephone numbers information inputted from the operating portion corresponding identification information to the telephone numbers; and the operating portion instructs the display portion to display the telephone number information recorded in the first memory portion together with the corresponding identification information recorded in the second memory portion.

According to further aspect of the invention, a digital radio telephone further comprises an operating portion for supplying an operating signal, a display portion for displaying various information during operation, wherein, the operating portion instructs the display portion to display the telephone number information one after another in a circulative way starting with telephone number information received most recently.

Preferably, the operating portion in the digital radio telephone instructs to make a calling process according to the telephone number information when predetermined telephone number information recorded in the memory is displayed on the display portion.

Preferably, the memory in the digital radio telephone comprises a first memory portion for storing the telephone number information included in the control information and a second memory portion for registering other telephone numbers information inputted from the operating portion corresponding identification information to the telephone numbers; and the operating portion instructs the second memory portion to register the predetermined telephone number information when the predetermined telephone number information recorded in the first memory portion is displayed on the display portion.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram showing a system configuration of a digital radio telephone of an embodiment of the present invention.

5 FIG. 2 is a functional block diagram related to a recording process of an incoming telephone number of the embodiment of the present invention shown in FIG. 1.

10 FIG. 3 is a block diagram related to a detailed process of a memory management means of the embodiment of the present invention shown in FIG. 2.

FIG. 4 is a flow chart related to the recording process of the incoming telephone number of the present invention.

15 FIG. 5 is a diagram to explain a storage configuration of the incoming telephone numbers of the present invention.

FIG. 6 is a flow chart related to a display process of the incoming telephone number of the present invention.

20 FIG. 7 shows a displaying order of the incoming telephone numbers in the present invention.

FIG. 8 is a flow chart related to an incoming redialing process of the incoming telephone number of the present invention.

25 FIG. 9 is a flow chart related to a memory dial registering process of the incoming telephone number of the present invention.

FIG. 10 is a diagram to explain a storage construction of the telephone numbers in the memory dial registering memory of the present invention.

FIG. 11 is a block diagram showing a system configuration of a conventional digital radio telephone.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1.

The present invention is concretely explained focusing on a digital radio telephone compatible to both a private (extension) line and a public (external) line.

FIG. 1 shows a system configuration of the digital radio telephone of an embodiment of the present invention. FIG. 1 comprises a microphone 1 which is used by a user of the digital radio telephone to input audio information such as speech as an analog audio signal, an A/D converter 2 for converting the inputted analog audio signal into a digital audio signal, a voice encoding / decoding portion 3 for encoding the digital audio signal outputted from the A/D converter 2 using a data compression encoding system such as a VSELP (Vector Sum Excited Linear Predictive Coding) system to obtain an encoded digital signal, and decoding the encoded digital signal in a reverse process to the encoding to obtain a digital audio signal, a switch 4 for selecting any one of the encoded digital signal from the voice encoding / decoding portion 3 or an encoded digital signal from a control signal processing portion 9 mentioned later, a radio portion 5 having a transmission modulating function for converting the encoded digital signal from the switch 4 into a radio signal transmitted by an antenna 6 and a reception demodulating function for converting the radio signal received by the antenna 6 into an encoded digital signal, a D/A converter 7 for converting the digital audio signal decoded by the voice encoding / decoding portion 3 into an analog audio signal, a speaker 8 for outputting the audio information as the analog audio signal, a control signal processing portion 9 for decoding a control information included in the encoded digital signal from the radio portion 5, and for encoding telephone number information stored in a memory 12 mentioned later, and outputting the telephone number information to the switch 4 as an encoded digital signal, a microcomputer 10 for recording the telephone number information included in the control information from the control signal processing portion 9 in the memory 12 according to the time when the information is received and for processing the telephone number information

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stored in the memory 12 in order to display it on the display portion 13 mentioned later by an operating portion 11, an operating portion 11 for reading the telephone number information out of the memory 12 for example and for inputting an operating information such as carrying out calling as an operating signal, a memory 12 for  
5 storing the telephone number information processed by the microcomputer 10 as an incoming record information, a display portion 13 for displaying a message in response to the operating information and various operations, and a control timing generating circuit 14 for controlling switching timing of the switch 4. FIG. 1 also comprises a voice processing portion 100 which comprises the A/D converter 2, the voice encoding / decoding portion 3, and the D/A converter 7.

10 FIG. 2 is a functional block diagram especially relates to a recording process of the incoming telephone number conducted in the microcomputer 10 in the system configuration of the digital radio telephone shown in FIG. 1. FIG. 2 comprises a telephone number information detecting means 40 for detecting whether the telephone number information is included in the control information from the control signal processing portion 9, a time information management means 50 for specifying a receiving time of the control information included the telephone number information according to the time from a clock portion (not shown) provided in the digital radio telephone and for outputting the time information, an extension / external line judging means 70 for identifying and judging whether the call is from the extension or from the external line in case the telephone number information exists by detecting extension / external line identification information included in the control information for example, an external line information addition means 80 for extracting the telephone number information from the control information and for outputting the telephone number information in case the call is from the extension line, while for extracting the telephone number information from the control information, and adding external line calling information to the telephone number information, then, outputting the  
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telephone number information as new telephone number information in case the call is from the external line, and a memory management means 60 for recording the telephone number information from the external line information addition means in the memory 12 as incoming record information in correspondence to the time information from the time information management means 50.

FIG. 3 is a functional block diagram especially relates to a detailed process conducted in the memory management means 60 shown in FIG. 1 which is the functional block diagram regarding the incoming telephone number process conducted in the microcomputer 10. In FIG. 3, a telephone number information comparison means 67 compares the telephone number information from the external line information addition means 80 with the telephone numbers previously recorded in the memory 12, and outputs ~~whether these telephone numbers~~ <sup>determines</sup> whether these telephone numbers are identical to each other. The operating portion 11 gives instructions to compare or not with the telephone number information. A vacant memory judging means 61 judges whether a vacant area exists in the memory 12 to store the telephone number information of a new incoming call according to an output of the telephone number information comparison means 67 ("record all" without comparison or "no identical information" as a result of comparison). A rerecording means 62 deletes unnecessary information (the oldest information or a plurality of identical information) of the incoming record information recorded in the memory 12 according to a judging result of the vacant memory judging means 61 ("no vacancy") or the output of the telephone number information comparison means 67 ("identical information" as a result of comparison) and keeps vacant areas to newly rerecord the remaining incoming record information. A recording means 63 records the telephone number information in a desired area in the memory 12 in correspondence to time information as an incoming record information according to "vacant" as a judging result of the vacant memory judging means 61 or "vacant" as a judging result of the re-recording means 62.

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FIG. 4 is a flow chart showing an operation of the recording process of the incoming telephone number. The operation of the present embodiment shown in FIG. 2 is explained using FIGS. 3 and 4.

First, in a step 401, the telephone number information detecting means 40 detects whether the telephone number information is included in the control information from the control signal processing portion 9. The process is completed in case the telephone number information is not included. In case telephone number information is included, the extension / external line judging means 70 identifies and judges whether the telephone is in the extension or in the external line in a next step 402. In case the call is in the external line, in a next step 403, the external line information addition means 80 adds external line identifying information ("0" as the external line calling number, for example) to the telephone number information in the control information. In case the call is in the extension, the external line information addition means 80 extracts the telephone number information from the control information and outputs the telephone number information. Then, in a step 404, the time information management means 50 specifies the time when the telephone number information is received. In a next step 405, the operating portion 11 instructs the telephone number information comparison means 67 to process a plurality of identical incoming telephone numbers received so-far. In case of recording all the identical incoming telephone numbers <sup>the</sup> ~~are to be recorded~~ <sup>where</sup>, the operation goes to a step 406. In case of recording <sup>the</sup> ~~where~~ <sup>where</sup> ~~received~~ only the latest incoming telephone number <sup>out of the identical incoming telephone</sup> ~~numbers~~, the operation goes to a step 410. In the step 410, the telephone number information comparison means 67 compares the incoming telephone number information recorded so-far in an incoming recording memory 121 with the latest incoming telephone number information <sup>so far</sup> ~~received~~ <sup>of</sup> ~~in~~ <sup>first memory</sup> ~~memory~~ <sup>the</sup> ~~where~~ <sup>close and correspond</sup> ~~to a~~ <sup>A2</sup>. In case the incoming telephone number information are not identical to the registered telephone number information, the operation goes to the step 406. On

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the other hand, in case incoming telephone number information is identical to the  
 registered telephone number information, the operation goes to a step 411. In the step  
 411, the recording means 63 deletes the incoming telephone number information  
 recorded so far in the incoming recording memory 121 and goes to a step 408. In the  
 step 406, the vacant memory judging means 61 judges whether there is an area for new  
 incoming telephone number information can be used in the incoming recording  
 memory 121. In case the incoming recording memory 121 has a vacant storage area  
 incoming telephone number information is recorded in the incoming recording  
 memory 121 together with the time information. In case the incoming recording  
 memory 121 is occupied, the operation goes to a next step 407, where the telephone  
 number information with the oldest time information is deleted from the incoming  
 recording memory 121. In the next step 408, the second oldest telephone number  
 information is incremented and recorded into the location in the incoming recording  
 memory 121 where the oldest time information is deleted. This operation is repeated  
 continuously. In a next step 409, the latest incoming telephone number information is  
 finally recorded together with the time information into a location in the vacant  
 incoming recording memory 121, and thereafter, the operation is completed. FIG. 5  
 shows a memory construction of the incoming telephone numbers and their incoming  
 times in the incoming recording memory 121. As shown in FIG. 5, the respective  
 incoming telephone number is stored in each address in combination with its incoming  
 time in the incoming recording memory 121.

FIG. 6 is a flow chart showing an operation of display processes of the  
 incoming telephone number recorded in the incoming recording memory 121. The  
 operation of the display processes is explained below using FIGS. 3 and 6. First, in a  
 step 601, the operating portion 11 instructs to display the recorded numbers.  
 In a next step 602, a memory record judging means 66 judges whether incoming  
 telephone number information is recorded so far into the incoming recording memory

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121. In case no incoming telephone number information is recorded ~~so far~~, in a step 603, *an indicating sound* is given from the speaker 8 to inform *the user* that no incoming telephone number information is recorded and also *a warning-indication* is displayed on the display portion 13, then, the display process is completed. In case, *the where* <sup>145</sup> incoming telephone number information is recorded, an incoming record reading means 64 reads *a recorded* <sup>145</sup> incoming telephone number received most recently together with its incoming time out of the incoming recording memory 121, and in a step 604, the display portion 13 displays the telephone number and the incoming time. In a next step 605, the display process finishes according to an instruction of the operating portion 11. In case of displaying other incoming telephone numbers, in a next step 606, the operating portion 11 instructs to switch the display indication of the incoming telephone number. In response to the instruction from the operation portion 11, in a step 607, the display of an immediately preceding incoming telephone number or an immediately succeeding incoming telephone number is switched back and forth. After that, the operation returns to the step 605, then, the steps 605, 606, 607 are repeated until a desired incoming telephone number is displayed.

FIG. 7 shows a displaying order of the incoming telephone numbers when five incoming telephone numbers are recorded. According to the instructions from the operating portion 11, the displayed telephone number circulates in an increment direction or a decrement direction of the recorded incoming telephone numbers one after another. In the above mentioned display processes (steps 604, 607), only the incoming telephone number information and the incoming time recorded in the incoming recording memory 121 are displayed. In case memory dial information corresponding to the incoming telephone number information is registered in a registering memory 122 which is mentioned later, additional information (e.g. name or company name corresponding to the telephone number) in the memory dial information can be displayed as a related information at the same time in addition to the

incoming telephone number information. In this case, in steps 604 and 607, the memory dial information in the registering memory 122 is searched (searching means is not shown) using a key word of the incoming telephone number which is read out by the incoming record reading means 64. Then, if the identical telephone number with the incoming telephone number is searched in the incoming record reading means 64, the additional information corresponding to the incoming telephone number is read out from the memory dial reading means 68 and displayed on the display portion 13.

FIG. 8 is a flow chart showing an operation of an incoming redialing process using the incoming telephone number recorded in the incoming recording memory 121. The operation of the incoming redialing process is explained below using FIGS. 3 and 8. First, in a step 801, the operating portion 11 instructs the display portion 13 to display a desired incoming telephone number. The detailed processes from the start to the display indication for displaying the incoming telephone number is the same as the display processes explained using FIG. 6. Next, in a step 802, the operating portion 11 instructs to carry out the incoming redialing. Then, in a next step 803, the telephone number information read out by the incoming record reading means 64 is transmitted as control information from the radio portion 5 to the mate telephone via the control signal processing portion 9 to make a telephone call.

FIG. 9 is a flow chart showing an operation of a memory dial registering process of the incoming telephone number recorded in the incoming recording memory 121. In general, a memory dial function includes functions for registering frequently-used telephone numbers and their related additional information (names, names of companies corresponding to the telephone numbers) in advance as memory dial information, for accessing a desired telephone number or additional information, for displaying it and for making a telephone call with less operations. The registering is explained using FIG. 3. First, a mate telephone number is inputted from the operating portion 11. Then, a registering means 65 registers the telephone number

into a desired area in the registering memory 122 which is a second memory portion in  
the memory 12. At this time, it is possible to register the telephone number  
corresponding to an abbreviated title of the mate name and so on if required. FIG. 10  
shows a storage construction of the mate telephone numbers and the related  
abbreviation of the mate names. As shown in FIG. 10, the telephone numbers are  
combined with the corresponding abbreviations and registered in respective addresses  
in the registering memory 122. An operation of the memory dial registering process  
of the present invention is explained below using FIGS. 3 and 9. First, in a step 901,  
a desired incoming telephone number is displayed on the display portion 13 according  
to the instructions of the operating portion 11. The detailed processes from the start  
to the display indication for displaying the incoming telephone number is the same as  
the display processes explained using FIG. 6. Then, in a step 902, the operating  
portion 11 instructs to register the memory dial. In a next step 903, the telephone  
number information read out by the incoming record reading means 64 is registered in  
a desired area in the registering memory 122, or the second memory portion, via the  
registering means 65.

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